REMARKS

Reconsideration and allowance of this application are respectfully requested. Currently, claims 1-17 and 20-50 are pending in this application.

Request of Approval of Drawing Changes:

Applicant filed amendments to the drawings on July 28, 2009 including a replacement sheet of drawings and an annotated sheet showing changes. Applicant requests approval and acceptance of these amendments to the drawings.

Rejection under 35 U.S.C. §102:

Claims 1-6, 17-25 and 36-40 were rejected under 35 U.S.C. §102 as allegedly being anticipated by Kuhn et al (U.S. '083, hereinafter "Kuhn"). Applicant traverses this rejection.

Anticipation under Section 102 of the Patent Act requires that a prior art reference disclose every claim element of the claimed invention. See, e.g., *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1574 (Fed. Cir. 1986). Kuhn fails to disclose every claim element of the claimed invention. For example, Kuhn fails to disclose "matching, by execution of a computer system, sub-field/frame elements of a test video field/frame with corresponding sub-field/frame elements of at least one reference video field/frame, and thereby generating for the test video field/frame a matched reference field/frame comprising the sub-field/frame elements of the at least one reference video field/frame which match to the sub-field/frame elements of the test video field/frame; [and] positioning, by execution of the computer system, in the matched reference video fields/frame at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame and the at least one matching sub-field/frame elements," as required by independent claims 1 and its dependents. Kuhn also fails to disclose "matching sub-field/frame

elements of a test video field/frame with corresponding sub-field/frame elements of at least one reference video field/frame, and thereby generating for the test video field/frame a matched reference field/frame comprising the sub-field/frame elements of the at least one reference video field/frame which match to the sub-field/frame elements of the test video field/frame; [and] shifting, by execution of the computer system, relative to the matched reference field/frame at least one of the matching sub-field/frame elements to compensate for misalignment between at least one of the sub-field/frame elements of the test video field/frame and the at least one matching sub-field/frame elements," as required by independent claim 17 and similarly required by independent claim 20, as well as their respective dependents.

Claims 1, 17 and 20 have been amended to clarify that the invention of these claims requires the shifting of parts of an image relative to the image as a whole in order to compensate for misalignments between parts of the reference image relative to parts of the test image. In more detail, a block from the reference field/frame is copied into the matched reference field/frame being constructed at a position corresponding to the position of a matched block within the test field/frame. The shifting of parts of an image required by the present claim amendments is supported by page 8, lines 7-20 and page 13, line 30 to page 15, line 7 of the original specification.

Section 1 (page 2) of the Office Action correctly notes that Applicant previously argued that "Kuhn fails to disclose compensating for movements of parts of an image relative to the image as a whole and to other parts of the image because Kuhn describes compensating for movement of a whole image relative to a whole image." With respect to this, section 1 (page 3) of the Office Action goes on to correctly state that "Kuhn teaches matching of the test alignment pattern corresponding the reference alignment pattern."

However, these parts of images (patterns or selected portions thereof) in Kuhn are matched so as to compensate for a pixel shift in the whole image. Matching of the patterns in Kuhn does not reduce the adverse effects of sub-field/frame misalignments between a reference and a test sequence. For example, there is no teaching in Kuhn of compensating for a pixel shift between the alignment pattern and another part of the same image.

Kuhn's abstract states, *inter alia*, the following (emphasis added):

> High precision image alignment detection uses an iterative part pixel shift detection algorithm to accurately determine *the displacement of a received image with respect to a reference image*. An alignment pattern is inserted into the original image and a portion of the alignment pattern, such as a single line, also is stored as a reference image. Using cross-correlation the received image is compared with the reference image to locate the alignment pattern, and selected portions of the received image alignment pattern are then used in conjunction with the reference image *to determine the total pixel shift of the received image*.

Consistent with Kuhn's abstract, Kuhn explicitly discloses applying a shift to the entire image. For example, column 4, lines 10-11 of Kuhn states "[t]he image from the image register is interpolated and loaded into a shifted register as the shifted image." At no point does Kuhn disclose or even suggest dividing a reference image into parts and applying a pixel shift to the parts independent of the image as a whole.

While Kuhn addresses determining the displacement of a whole, entire image, not the matching of a plurality of subfield/frames of an image – as presently claimed (see the explicit recitation of "sub-field/frame elements" which clearly requires a plurality of elements).

Kuhn uses one part of a test image (the "*alignment pattern*") and one part of a reference image (a copy of the "*alignment pattern*" or a part thereof). However, these single parts are employed to determine the offset for the entire image, and do not reduce adverse effects of sub-field/frame misalignments between the reference and test sequences.

Col. 2, lines 41-47 (specifically identified by the Office Action) of Kuhn discloses: "[t]he detection requires access to a reference image (an image from the original video sequence or corresponding to it exactly) or a portion of it." However, the recited "detection" in this portion of Kuhn is a "high precision image alignment detection" (see col. 2, lines 41-47). Kuhn thus describes image alignment, i.e. using a single line (or other part) of an image in order to detect the offset of that image as a whole. The use described by Kuhn of a single line (or other part) of an image does not correspond to manipulation of the sub-field/frame elements as required by the independent claims.

Kuhn [U.S. Patent No. 6,295,083] is discussed briefly in the background of the original specification (pg. 2). Namely, page 2, lines 14-30 of the original specification states the following (emphasis added):

> Problems can arise, however, with straightforward comparisons of test and reference sequences to generate the quality metrics mentioned above. For example, spatial or temporal misalignment between the ***whole*** or parts of the reference and the test sequence can greatly affect such measurements, but may be perceptually insignificant to a human viewer. Such misalignments must be handled if difference measures are to contribute to reliable and practical full reference assessments.
>
> Constant spatial and temporal misalignments are commonly encountered in full reference test situations, and can be countered by "one off" alignment applied to the ***whole*** reference or degraded sequence. Examples of prior art documents which deal with such one off alignments are U.S. Pat. No. 6,483,538, U.S. Pat. No. 6,259,477, U.S. Pat. No. 5,894,324, U.S. Pat. No. 6,295,083, and U.S. Pat. No. 6,271,879. Additionally, field-based spatial or temporal jitter, where misalignments might vary between fields, can be handled by similar techniques applied on a field by field basis. However, more complex, but equally imperceptible, misalignments may also occur ***within a field or frame, where different regions of a video field or frame might be subject to different shifts, scaling, or delay***. For example, spatial warping, missing lines, or frozen blocks can occur through video processing and need to be taken into account of if a picture quality assessment metric is to be produced automatically which can be used in place of human subjective testing results.

The problems identified above are clearly not appreciated by Kuhn, let alone addressed by Kuhn. In particular, the above-noted misalignments within a field or frame are not dealt with by Kuhn. On the other hand, this problem is addressed by the invention of independent claims 1, 17 and 20 by shifting one or more of the matching sub-field/frame elements to compensate for misalignment between the sub-field/frame elements of the test video field/frame and the matching sub-field/frame elements of the matched reference field/frame. This is not addressed by the alignment detection of Kuhn -- which only teaches shifting whole images.

The invention of independent claims 1, 17 and 20 relates to the creation of a new matched reference field/frame which is more than just the shifted version of the reference signal (e.g., as provided by the method of Kuhn). Unlike the prior art, where a reference array is generated by simply shifting an entire image, the invention of claims 1, 17 and 20 divides the test array into a plurality of sub field/frame elements and searches in the reference signal for a "best match" for each sub field/frame element. The "best match" sub field/frame elements are searched for in the reference signal at various offsets to the position of the corresponding sub field/frame element of the test signal and/or across several adjacent fields/frames. Once selected each "best match" block is copied into the new, matched reference field/frame and shifted, as necessary, into a position matching the position of the corresponding test sub field/frame. In this way, the invention of claims 1, 17 and 20 provides compensation for the complex misalignments that may occur <u>within</u> a field or frame, where different parts of a video field or frame might be subject to different shifts, scaling, or delay. These misalignments <u>within</u> a field or frame (i.e. affecting a sub-field/frame element) are not addressed by Kuhn.

Dependent claim 2 further requires "wherein the matching further comprises, for a sub-field/frame element of the test video field/frame, searching for a matching sub-field/frame element within M1 preceding and/or M2 succeeding reference video fields/frames to a temporally corresponding reference video field/frame to the test video field/frame." Similar comments apply to dependent claims 21 and 36.

Kuhn does not teach the use of cross-correlation implied by the Examiner, i.e. to compare successive images in a sequence of images. For example, at column 1, lines 51-55, the concept of cross-correlation is introduced as follows:

> [t]he detection is a four stage process, with the first two stages being used to locate an alignment pattern in a received image by cross-correlation with a reference image corresponding to the alignment pattern. This detects an integer pixel shift +/-0.5 pixel.

Kuhn refers to cross-correlation of an alignment pattern in _a_ received image with _a_ reference image – i.e., correlation between a <u>single</u> test image and a <u>single</u> reference image. This wording excludes searching for a matching sub-field/frame element within M1 preceding and/or M2 succeeding (i.e., more than one) reference video fields/frames. Column 5, lines 7-10, the system of Kuhn is summarized as follows:

> "[t]hus the present invention provides high precision image alignment detection by locating an alignment pattern in <u>a</u> received image using cross-correlation with <u>a</u> reference image corresponding to the alignment pattern . . .".

Cross-correlation, as normally defined has no sensible application in the alignment detection method of Kuhn. The standard definition of cross-correlation, which the Office Action apparently invokes, may be summarized as follows: the time integral of the product of one signal f(t) and another signal g(t) related to the first but time-delayed (e.g. by τ). In mathematical notation, this would be represented as follows:

$$\int_0^t f(t)g(t-\tau)dt$$

This would have the effect, in the video context of Kuhn, of comparing successive images from the test signal (i.e., images received over the time interval 0 to t) with successive images from the reference signal offset by $-\tau$ (i.e., images received over the time interval $-\tau$ to t$-\tau$). This application of cross-correlation does not agree with the method taught in Kuhn, where the pixels of a single image are compared for correlation with the pixels of a second single image in order to detect a pixel shift between two images by exploiting an alignment pattern common to both images. One skilled in the art would appreciate the specific use of cross-correlation taught in Kuhn relates to spatial cross-correlation, rather than temporal, and that this is incompatible with the standard definition relied on by the Office Action. Kuhn simply does not teach any matching of image elements across preceding and/or succeeding reference video fields/frames.

Applicant therefore requests that the rejection under 35 U.S.C. §102 be withdrawn.

Claims 7-16, 26-35 and 41-50 were rejected under 35 U.S.C. §103 as allegedly being unpatentable over Kuhn in view of Wolf et al (U.S. '083, hereinafter "Wolf"). Applicant traverses this rejection. Claims 7-16 depend at least indirectly from claim 1, claims 26-35 depend at least indirectly from claim 20, and claims 41-50 depend at least indirectly from claim 17. All of the comments made above with respect to Kuhn thus apply equally to claim 7-16, 26-35 and 41-50. Wolf fails to resolve the above-described deficiencies of Kuhn.

Wolf describes a full-reference objective quality assessment method that uses feature extraction followed by quality classification. The feature extraction process requires time-alignment and includes the calculation of "temporal features." Wolf further describes the

measurement of various forms of "impairment" based on features extracted from sampled video, including spatial blurring, temporal blurring, etc. The time-alignment and temporal feature extraction processes of Wolf appear to be frame-based. Wolf fails to achieve or even consider the sub-field/frame element matching of claim 1, 17 or 20, or the claimed shifting.

The Office Action correctly indicates that Wolf refers to statistical analysis. However, this statistical analysis is not part of the video quality assessment arrangement of Figure 2. The statistical analysis described in Wolf forms part of the development process used to <u>design</u> the video quality measurement system illustrated in Figure 2 (see col. 3, lines 4-6), but does not form part of it. The statistical analysis described in Wolf does not generate the one or more matching statistic values and/or matching vectors of claims 7, 26 and 41, but produces a set of source and destination features which determine the internal functioning of the statistics processors 22, 24, 30, and 32 of the video quality measurement system of Figure 2 (see col. 6, lines 3-13). The statistics processors 22, 24, 30, and 32 do not generate statistical values, but compute a set of source features (col. 4, lines 26-35) and destination features (col. 5, lines 13-29). Despite their names, these functional blocks of Wolf do not perform the invention of dependent claim 7, 26 or 41.

The method of independent claim 1 acts to minimize the effects of sub-field/frame misalignments that are imperceptible to the human viewer. Wolf fails to teach or suggest this. These "imperceptible" sub-field/frame misalignments are not so severe as to be noticeable to the human viewer, but can significantly affect the quality value generated by an automatic quality measuring system leading to the generation of inaccurate values. The use of a matching element that is smaller than the video field/frame size enables transient sub-field/frame misalignments to be effectively tracked. This is not identified as being a

characteristic of the quality measurement system of Wolf. Indeed, no part of Wolf considers transient sub-field/frame misalignments.

Wolf refers to video frame features from the perspective of bandwidth-reduction. In particular, the source and destination features of Wolf are not sub-fields of a video frame, but bandwidth-reduced representations of the entire frame.

Wolf discloses extraction of features from the video signal being implemented in order to reduce the bandwidth of the signal to allow comparison of signals (source and destination) at geographically remote locations (see col. 3, lines 45-50; col. 5, lines 18-23). According to Wolf, source features are produced by statistics processors 22 and 24 for source video and by statistics processors 30 and 32 for destination video (col. 5, lines 18-21). Col. 5, lines 32-37 discloses that "the system of the [Wolf's] present invention provides human perception-based quality parameters 13 and quality score parameter 14." These features are extracted separately from source and destination videos and exchanged between source and destination "instruments" via a communications channel distinct from the video channel. These features are generated by extracting information from the true video signals and processing that information in the hope of capturing perception-affecting characteristics for comparison.

For all of the above reasons, the invention of the independent claims provides significant benefits over Kuhn and Wolf by enables more effective identification of visually significant imperfections in a video signal. By identifying imperfections imperceptible to the human viewer (such as the misaligned image sub-blocks), the invention of the independent claims enables automatic video quality detection to exclude these effects and provide a result better aligned with the experience of a human viewer.

Applicant therefore requests that the rejection under 35 U.S.C. §103 be withdrawn.

Conclusion:

Applicant believes that this entire application is in condition for allowance and respectfully requests a notice to this effect. If the Examiner has any questions or believes that an interview would further prosecution of this application, the Examiner is invited to telephone the undersigned.

Respectfully submitted,

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